WWSIS III: Western Frequency Response and Transient Stability Study

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TRC Call
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Today's Call

- Purpose:

Review planned final steps in project, with specific emphasis on review and refinement of proposed sensitivity cases and mitigation investigation.

- Items:

1. Review "next steps" from TRC 2-4-14 meeting notes
2. Discuss other TRC post-meeting inputs
3. Refine plan

Next Steps

(from 2-4-2014 meeting Notes)

- The main part of the frequency response and transient stability analysis, which focused on the four light spring and heavy summer study scenarios, is nearing completion. The remaining work will focus on further analysis of the simulations run to-date, and additional sensitivity cases. Please keep in mind that WWSIS 3 is an applied research study, rather than a comprehensive transmission planning study. Therefore, the objective of the sensitivity analysis is to define a band of potential responses, indicate general impact (e.g., better or worse), and provide insight into specific dynamic performance questions raised by the TRC. The further investigation of cases and new sensitivities under consideration are:.....
- *The following slides are presented/grouped by challenge.*

Sensitivity/causality of FRO Concerns

progress

- Headroom depletion as described in the TRC meeting.
  - Duck plots (in back up of this deck)
- Evaluate system response to a large distributed generation outage alone, and compare that to an equivalent but more localized outage of a conventional generation plant.
  - We will trip approximately 2700 MW of DG (PV) via the complex load model, and check the FR
  - This test also relates to other stability investigation, so will check on other stability impacts (see below)
- Illustrate impact of changes to dispatch and/or commitment (e.g. replace non responsive units with governor responsive units, replace 1000MW wind with hydro)
  - This first part will focus on illustrating sensitivities under the Hi-Mix cases
  - Will execute selected one-to-one changes in commitment and dispatch … think partial derivatives

Mitigation of FRO Concerns

progress

- Apply frequency controls to wind plants
  - Multiple tests. 5% of possible production reserved on:
  - (a) All new wind plants (i.e. those added to case to create Hi-Mix (case 3), for Light Spring '22
  - (b) Only new wind plants in areas short of FRO
  - Look at impact on total WECC FR and individual area performance. Not intended to iterate to calculate exact amount of incremental response from wind required to "fix" this particular case.
  - Governor response, inertial response and combination of both to be tested.
- Apply frequency controls to solar plants
  - Partly done, when we added governor response to CSP
  - Will add 5% FR to new utility scale PV
- Add energy storage for Frequency Response
  - Add inverter based energy storage (e.g. battery system) to areas short of FR
  - Determine (approximately) the amount of ES required to bring FR = FRO in those areas
- Illustrate impact of changes to dispatch and/or commitment
  - This 2nd part will enable responsive generation in areas that are deficient.

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Further Investigation of Stability

progress

- Discuss/analyze retirements. Any coal plants de-committed in a snap shot power flow could be considered retired. Explore impact on system performance.
  - Check for changes/concerns on transient stability…
  - These cases will use the light spring extreme case, in which there are acute changes in dispatch and commitment of thermal plants -- from perspective of this study, having units decommited is largely indistinguishable from them being retired
  - Will report on changes in unit commitment, with particular attention to coal plants.
  - Expect to test fault scenarios, especially in Northeast and Desert Southwest regions,
  - Will look for conditions of low short circuit strength
  - Investigate sensitivity to wind plant controls… baseline modeling of newly added wind plants will be tested for credible other behavior …e.g. less aggressive voltage regulation; attempt to capture aspects of recent "mix" of wind generation added.
  - Ditto for utility scale PV plants.
- Investigate possible relay impacts/issues.
  - This will be primarily screening of impact on key relay variables with high renewables. Will also focus on sensitivity/comparisons marginal impact on current, apparent impedance, voltage trajectories at COI and other nodes for one-to-one substitution of wind (or solar) for synchronous generation.
- Additional fault scenarios, e.g. Grizzly transfer trip. **Please provide detailed description of fault and any associated RAS.**

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Backup

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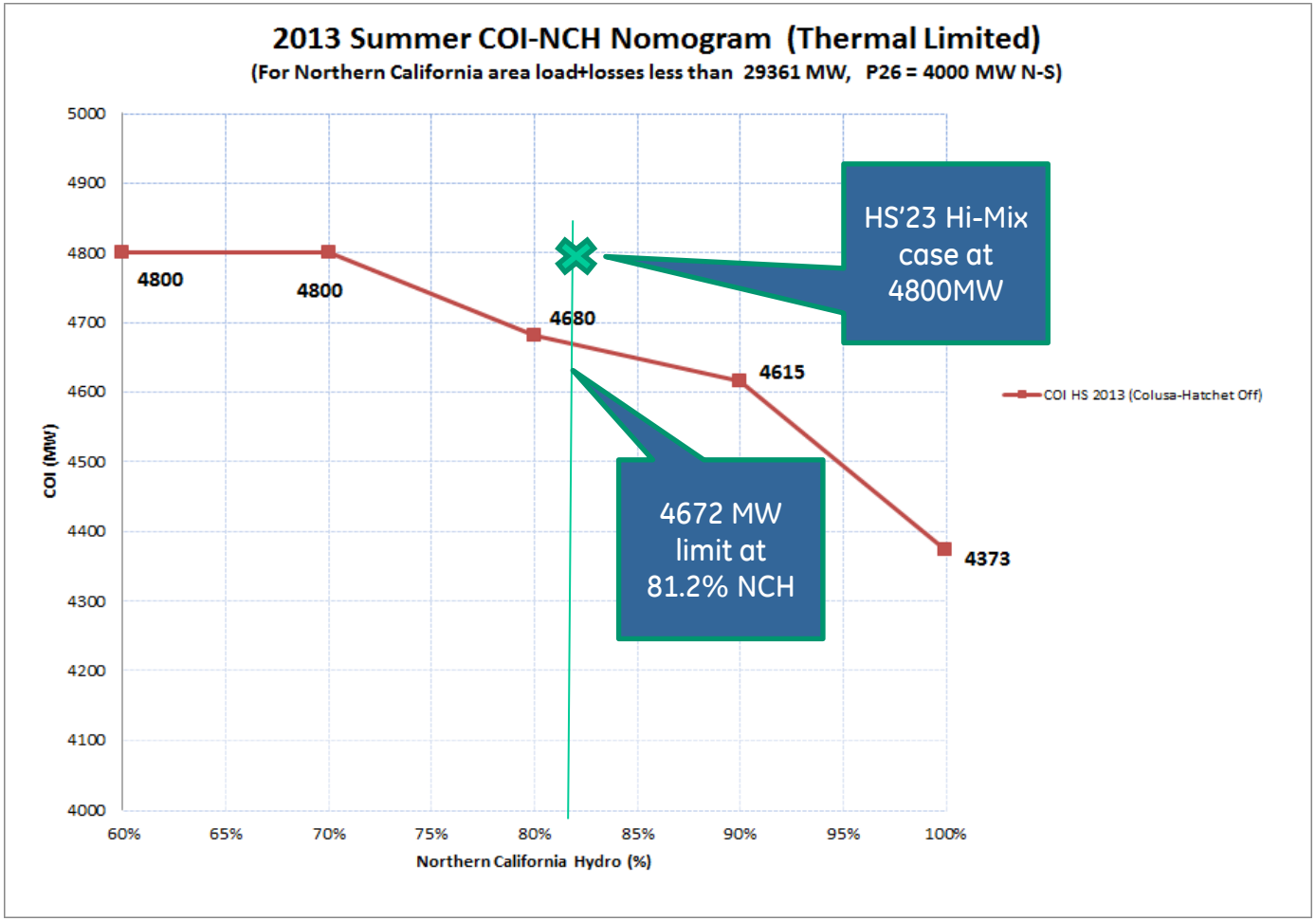
COI – NCH limits/stress

- HS'23: 81.2%
- HS-HiMix: 81.2%
- LSP'22: 47.1%
- LSP-HiMix: 47.0%



This figure per information from Janice Zewe, SMUD (thanks!). Actual limit on COI because of thermal limit to south is 128MW lower than was enforced in Heavy Summer. Therefore cases run on HS'23 are at slightly higher stress than thermal limits would allow. We would expect stability performance to improve if we destressed COI.

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Frequency Response: Regions and Areas deficient

This slide from TRC 2-4-14…with deficiencies highlighted

ID	Name	ID	FRO [MW/0.1Hz]	FR [MW/0.1Hz]	%of WECC FR	FR margin [MW/0.1Hz]	Freq. Nadir [Hz]	Nadir time [s]	Setl. Freq. [Hz]	Kt
1	WECC	WE	840	1311	100.00	471.4	59.646	7.19	59.844	0.42
2	CALIFORNIA	CA	296	312	23.76	15.9	59.642	7.29	59.844	0.33
3	DSW	DS	220	119	9.09	-100.8	59.641	7.38	59.844	0.27
4	NORTHEAST	NE	82	47	3.60	-34.2	59.642	7.38	59.843	0.30
54	ALBERTA	AL	0	0	0.00	0.0	59.627	6.23	59.842	0.23
14	ARIZONA	AZ	104	50	3.79	-54.7	59.640	7.38	59.844	0.29
50	B.C.HYDRO	BC	0	0	0.00	0.0	59.635	5.95	59.844	0.95
11	EL PASO	EL	9	4	0.29	-4.8	59.635	6.71	59.844	0.30
60	IDAHO	ID	18	22	1.66	3.9	59.643	7.77	59.843	0.68
21	IMPERIALCA	IV	4	14	1.10	10.5	59.638	7.38	59.844	0.16
26	LADWP	LA	29	30	2.27	0.5	59.641	7.10	59.844	0.42
20	MEXICO-CFE	MX	0	0	0.00	0.0	59.641	7.10	59.844	0.59
62	MONTANA	MT	11	10	0.78	-1.0	59.645	7.86	59.843	0.23
18	NEVADA	NV	28	34	2.59	6.0	59.637	7.00	59.844	0.52
10	NEW MEXICO	NM	14	2	0.14	-12.6	59.641	7.77	59.844	0.03
40	NORTHWEST	NW	131	483	36.86	352.6	59.644	7.77	59.844	0.62
65	PACE	PC	42	8	0.62	-33.6	59.641	7.29	59.843	0.19
30	PG AND E	PG	133	197	14.98	63.8	59.643	7.38	59.844	0.46
70	PSCOLORADO	CO	36	6	0.45	-29.7	59.638	7.10	59.843	0.25
22	SANDIEGO	SD	21	7	0.55	-14.1	59.640	7.00	59.844	0.16
64	SIERRA	SP	11	7	0.53	-3.6	59.639	7.29	59.844	0.18
24	SOCALIF	SC	108	63	4.84	-45.0	59.640	7.19	59.845	0.21
52	FORTISBC	FB	0	0	0.00	0.0	59.635	5.95	59.843	0.67
73	WAPA R.M.	WR	27	24	1.85	-3.2	59.641	7.19	59.843	0.19
63	WAPA U.M.	WU	0	3	0.20	2.5	59.646	6.04	59.843	0.76

- Frequency Response metric for 22LSP HiMix case for 2xPV event

Loss of headroom: Ducks

This slide from TRC 2-4-14

- Discussion with CAISO (thanks Clyde Loutan)
- Recent concern over emerging net load profile with strong mid-day solar…Duck Curves
- Commitment and dispatch to accept high solar can leave system short of responsive resources in the evening when solar drops off and before wind picks up
- Particular concern that FRO will not be met, especially for some individual BAs

Spring Ducks

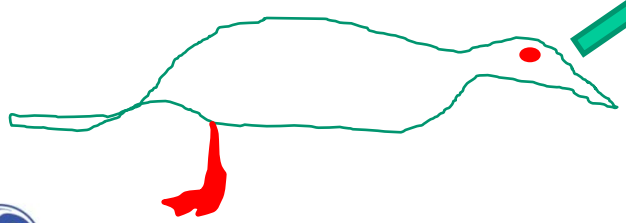
This slide from TRC 2-4-14

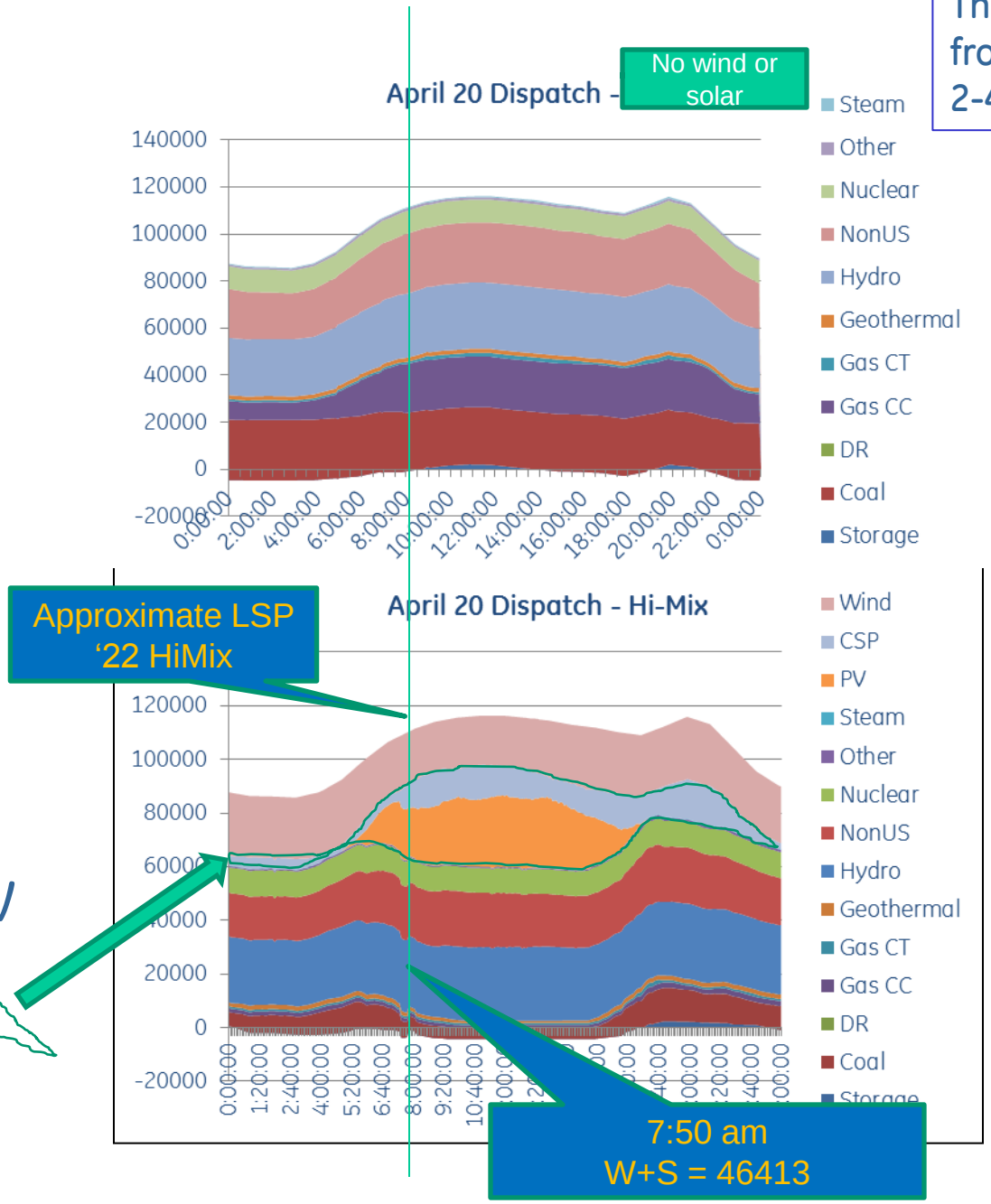
- These are from PLEXOS
- LSP HiMix was developed to investigate very instantaneous penetration:

Load = 109.5GW

W+S = 52.8 (48% penetration)

Headroom = 21.9GW





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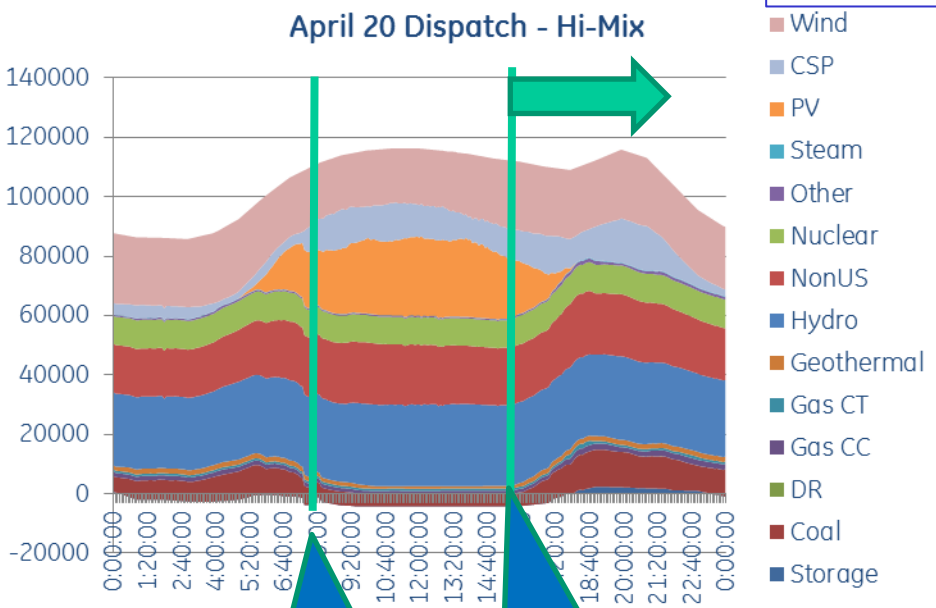
Squeezing the Duck: Headroom experiments

This slide from TRC 2-4-14

Proposed investigation

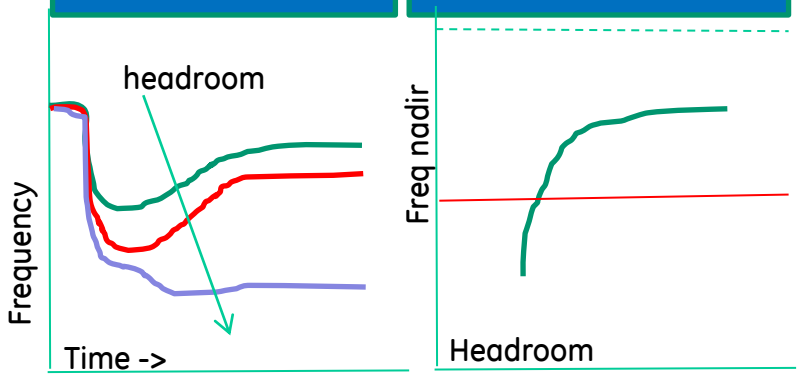
- Fix Commitment
- In steps (of say 4000MW)
  - Decrease wind & solar
  - Dispatch up units (identified by Plexos dispatch sensitivity
  - Recalculate headroom, Kt, etc.
- Run Palo Verde 2 event
  - Observe frequency
  - Calculate FR
- Repeat until UFLS or other fail
- Plot performance
  - vs. renewable power
  - vs. headroom

- NB: suggest this be done on the CSP sensitivity case, and disregard CSP thermal storage



7:50 am
W+S = 46413
Roughly our nominal LSP HiMix condition

Later, when the renewables are getting ready to drop looks very similar



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Location Aspects of FR

This slide from TRC 2-4-14 .with notes

- Deeper dive into FR and FRO may be warranted
- Specifically locational aspects.
- What are consequences of meeting overall IFRO while missing local FRO?

Focus of current trajectory

- Are there other big generation trip events that we should be worrying about?
- Are there other performance or system variables we should be monitoring, reporting?
- Should we look at over-frequency events?
- More investigation of Canada contribution/behavior?
- Other sources of FR, e.g. loads or storage?

Not on current trajectory

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Complex Loads, Distributed PV and 1547

- Composite Load w/ DG model has huge capabilities…and some limitations
- We showed
  - preliminary experiments with LVRT and LFRT
  - Some investigation of complex load behavior
  - This is of considerable interest to the seems to be a high priority to the industry… it will have a pivotal effect on the viability of widespread embedded PV
- But, the core issues, complex load and 1547 behavior, are out of the scope of this work
- We think this very important topic warrants follow-on work (ASAP).

NB: We are not planning to do more on this topic in *this* study.

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